

Trap catches of the sweetpotato whitefly (Homoptera: Aleyrodidae) in the Imperial Valley, California, from 1996 to 2002

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Abstract An outbreak of the sweetpotato whitefly, *Bemisia tabaci* (Gennadius), biotype B occurred in the Imperial Valley, California in 1991. The insects destroyed melon crops and seriously damaged other vegetables, ornamentals and row crops. As a result of the need for sampling technology, we developed a whitefly trap (named the CC trap) that could be left in the field for extended time periods. We used the traps to monitor populations of *B. tabaci* adults during year-round samplings from 1996 to 2002 to study variations in the weekly trap catches of the insect. The greatest number of *B. tabaci* adults was recorded in 1996, followed by a continuing annual decrease in trap catches each year through 2002. The overall decline of *B. tabaci* is attributed in part to the adoption of an integrated pest management (IPM) program initiated in 1992 and reduced melon hectares from 1996 to 2002. Other factors may also have contributed to the population reductions. Seasonally, *B. tabaci* trap catches decreased during the late summer and fall concurrent with decreasing minimum temperatures that are suggested to be a significant factor affecting seasonal activity and reproduction.

Key words *Bemisia tabaci* biotype B, CC trap, cotton, melons, ornamentals
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Introduction

Whiteflies are economically important pests worldwide. The sweetpotato whitefly, *Bemisia tabaci* (Gennadius) biotype B, has a wide host range occurring on more than 540 plant species in 77 families (Gill, 1992; Basu, 1995). In most agricultural areas of southwestern United States, a year-round source of host plants provide *B. tabaci* shelter, food and reproduction habitats (Chu *et al.*, 2001). In the Imperial Valley, California, 58 species of agronomic and horticultural plants and 19 weed species were identified as *B. tabaci* reproductive hosts (Natwick *et al.*, 2000). Eco-

nomic losses that included crop values and other costs were estimated to exceed \$961 million in three crop years from May 1991 to April 1994 (Birdsall *et al.*, 1995). Spring melons provide a host for *B. tabaci* population reproduction and dispersal to cotton. In the fall, *B. tabaci* disperses from cotton to fall melons, broccoli, and other winter hosts. Some evergreen perennials, such as arrow weed, *Pluchea sericea* (Nutt) (Coville), greaseweed, *Sarcobatus vermiculatus* (Hood), hogpotato, *Hoffmanseggia densiflora* (Ort) (Eifert), and nightshade, *Solanum* plant species that generally abound in fields following melon culture, serve as intermediate hosts and support populations of *B. tabaci* year-round (Natwick *et al.*, 2000). The sequential continuum of hosts is of particular concern because dispersal from one host to another has, in many cases, hampered management efforts. Factors affecting *B. tabaci* adult flight behavior and dispersal have been reported (Blackmer

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& Byrne, 1993; Chu *et al.*, 1995; Issacs & Byrne, 1998; Byrne, 1999), but much additional information is needed.

The adoption of an integrated pest management program (IPM) in 1992 in Arizona and California that included an environmentally acceptable insecticide has given exceptional *B. tabaci* control. Imidacloprid (Admire®) (1-[6-chloro-3-pyridylmethyl]-N-nitro-2-imidazolidinimine) used on an emergency basis in 1992 and 1993 has proven to be an effective systemic insecticide for melons, other vegetables and ornamentals, and continues at the present as a vital component of the whitefly management program. More recently, other neonicotinoid insecticides and insect growth regulators have also been included in the *B. tabaci* control program.

The objectives of this report were: (i) to document *B. tabaci* variations in trap catches in Imperial Valley, California from 1996 to 2002; and (ii) to identify factors effecting seasonal trap catches by studying differences in

catches near different host crops and during changing weather conditions.

Materials and methods

Based on color, light orientation and landing behavior of adult *B. tabaci*, we developed a non-sticky trap (named the CC trap) that allowed more cost-effective, efficient trap service scheduling time and maintenance (Chu *et al.*, 1995, 2001). The CC trap does not lose efficacy because of dust, debris and insect contamination associated with sticky traps. In 1996, 24 CC traps were installed around the periphery of the Imperial Valley, California and six traps were placed along a north-south line through the central area of the valley (numbered 1–24 and 25–30, respectively) for monitoring weekly whitefly catches (Fig. 1). Traps were located near the edges of farmlands, banks of irriga-

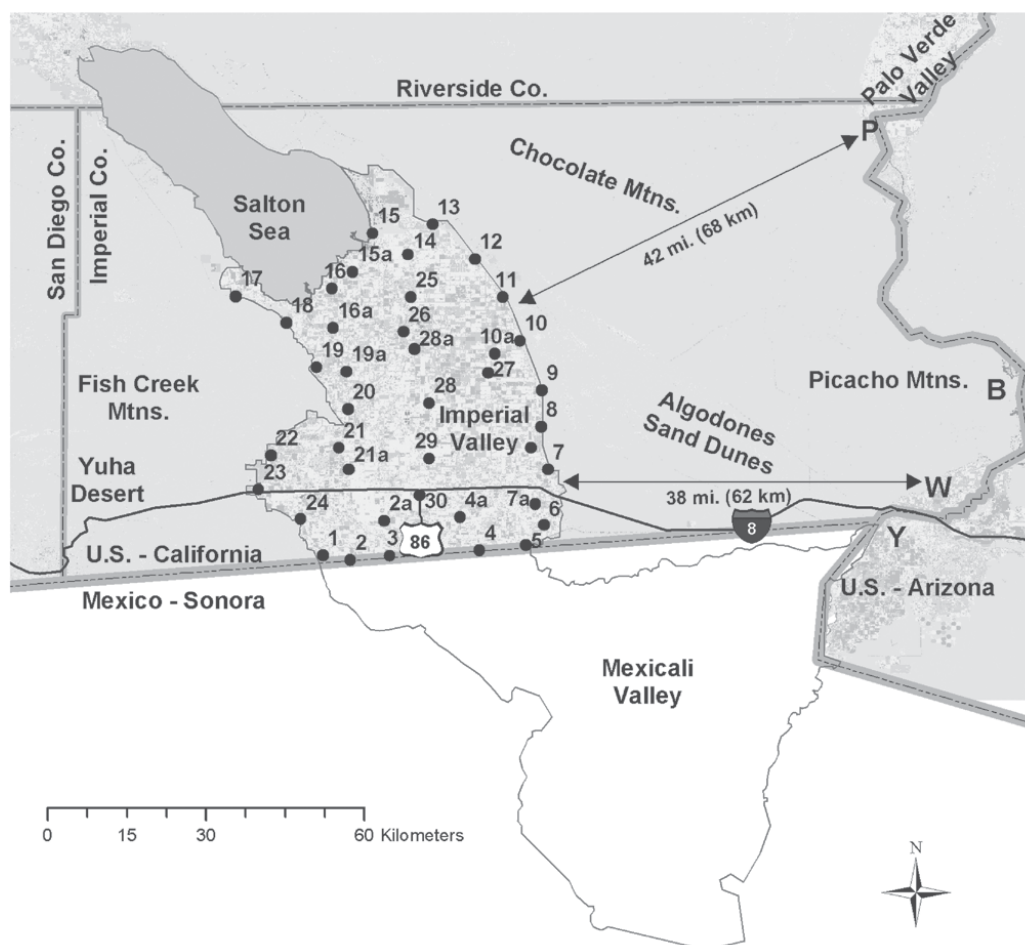


Fig. 1 Geographical locations of CC whitefly traps in Imperial Valley, California from 1996 to 2002. Traps 1–24 and 25–30 were located around the perimeter and the north-south trap-line of the Imperial Valley, respectively. Traps 2a–28a were additional traps installed in areas planted with melon crops in 1999.

tion canals or roadways for easy accessibility. The geographic coordinates of each trap site was determined using a differentially corrected global positioning system (GPS) receiver (Trimble model AgGPS-132, equipped with Omnistar L-Band correction and ArcGIS 9.0 Software, Redlands, CA). Traps were suspended 1.4 m above ground on wooden stakes, and were separated by at least 8 km. In 1999, 10 additional traps (numbered 2a, 4a, 7a, 8a, 10a, 15a, 16a, 19a, 21a, and 28a) were added at melon-planting locations. Melon plants are a preferred host for *B. tabaci* (Chu *et al.*, 1995). All traps were replaced weekly and catches of *B. tabaci* adults were counted beginning with week#13 (29 March) of 1996 and continued thereafter until the last week of December 1999. From 2000 to 2002, adult catches were counted weekly. However, because trap catches during weeks 1–12 and 47–52 were low ($< 0.13 \pm 0.10$ adults/trap/week), only trap catches from weeks 13–46 were summarized and are reported herein.

Mean monthly air temperatures (minimum, maximum, and average), rainfall, and hectares of melons grown in the Imperial Valley, California were provided by the Imperial Irrigation District, Imperial, CA and the County Agricultural Commissioner's Office, El Centro, CA, respectively.

Data analyses

Means of the 34 weekly whitefly trap catches for weeks 13–46 were plotted to show seasonal distributions during 1996–2002. The relationships of the yearly whitefly trap catches and melon crop hectares, and weather elements were analyzed using regression and correlation analysis (\hat{Y}

$= \alpha + \beta x$) (Michigan State University, 1994) with *t*-values accepted as significant at $P = 0.05$.

Results

Mean weekly trap catches of adult *B. tabaci* were highest for 1996 and decreased each year through 2002, except for 2001 ($\hat{Y} = 3731 - 1.864x$, where \hat{Y} is the year and x is trap catches; $r = 0.847$, $t = 3.557$, $P = 0.016$) (Fig. 2). Mean (\pm SE) numbers of adults caught/trap/week were 13.8 ± 2.9 , 8.1 ± 2.2 , 2.9 ± 0.8 , 1.9 ± 0.4 , 1.8 ± 0.4 , 1.9 ± 0.5 , and 0.9 ± 0.2 for 1996, 1997, 1998, 1999, 2000, 2001, and 2002, respectively. Numbers of melon hectares grown in the Imperial Valley were the highest in 1996. Production decreased significantly each year thereafter through 2002, except for 1999 ($\hat{Y} = 1.205 \times 10^6 - 599.50x$, where \hat{Y} is the year and x is melon hectares; $r = -0.935$, $t = 5.918$, $P = 0.002$) (Fig. 2). Hectares of melons grown were 8 147, 6 874, 7 805, 6 462, 5 258, and 5 134 for 1996, 1997, 1998, 1999, 2000, 2001, and 2002, respectively. Mean weekly catches of adult *B. tabaci* in traps decreased significantly as melon hectares decreased from 1996 to 2002 ($\hat{Y} = -13.793 + 0.003x$, where \hat{Y} is melon hectares and x is the trap catches; $r = 0.770$, $t = 2.696$, $P = 0.043$) (Fig. 2). Correlations between whitefly trap catches and number of hectares of alfalfa, cotton, broccoli, cabbage, or tomatoes were not significant and data are not tabulated.

In general, *B. tabaci* catches in traps 2a–28a located near melon plantings were higher but they were not statistically different compared with catches in traps 1–30 (Fig. 3).

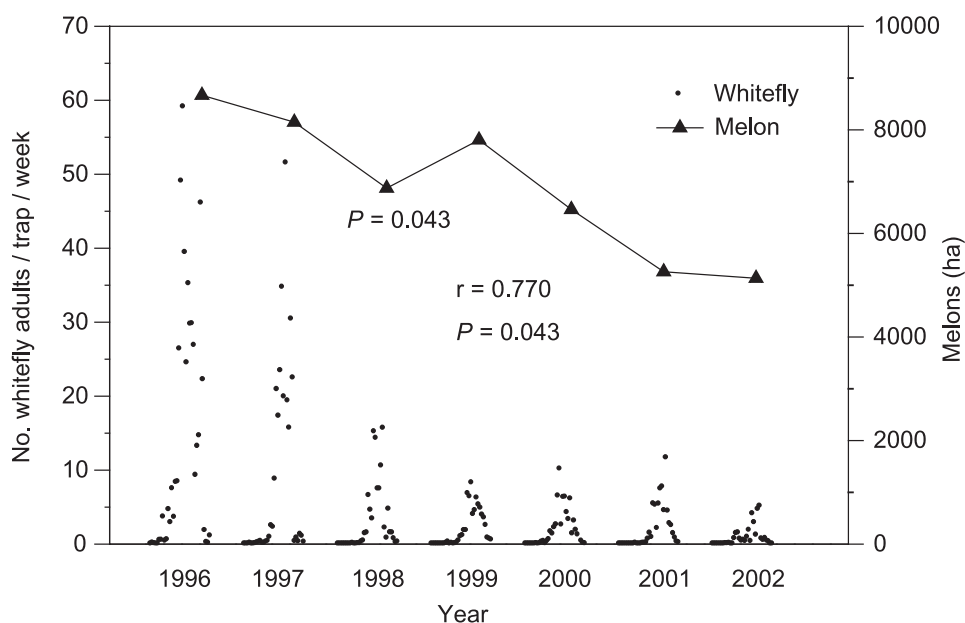


Fig. 2 Mean numbers of *Bemisia tabaci* caught per week, weeks 13–46 in CC whitefly traps 1–30 and melon hectares in the Imperial Valley, California during 1996 to 2002.

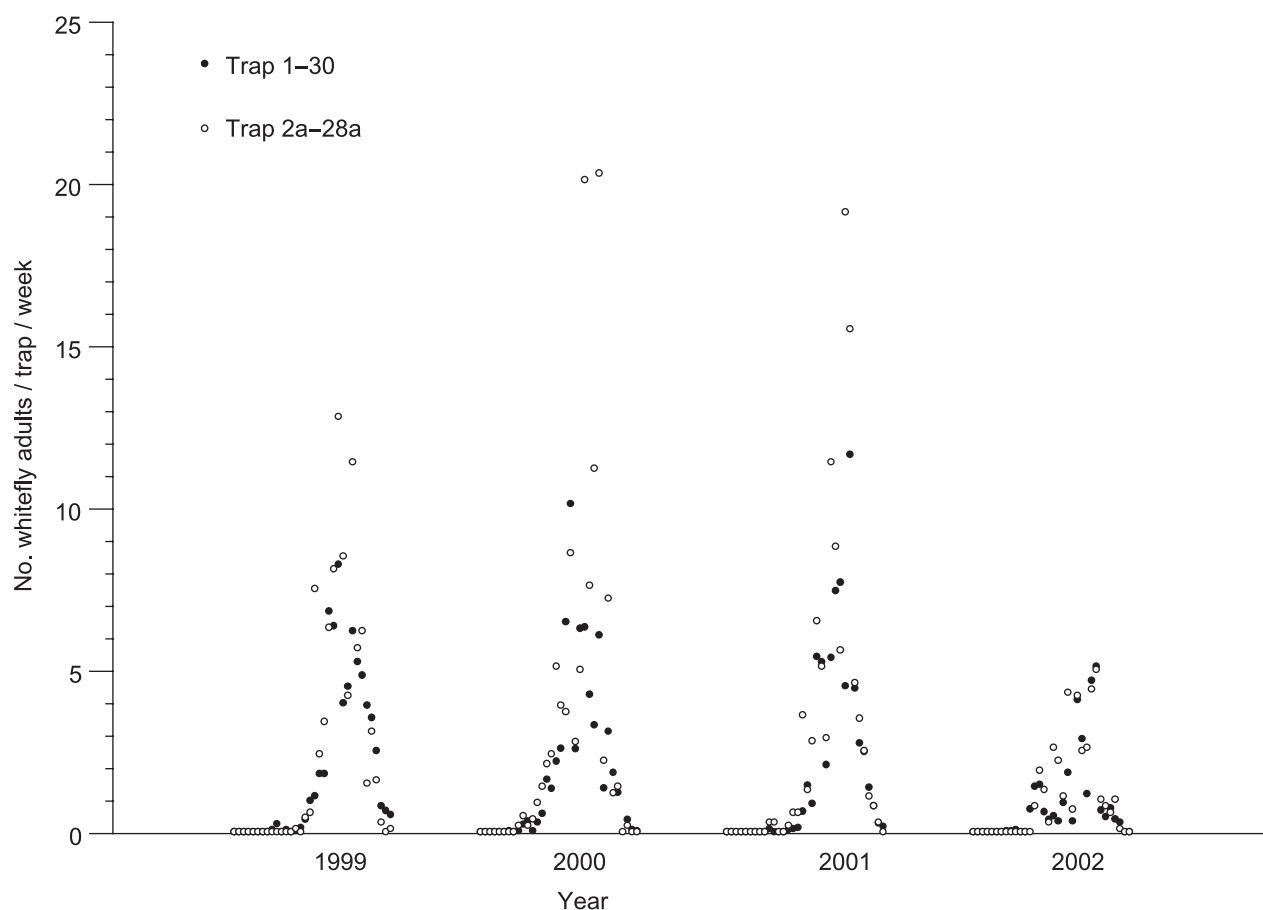


Fig. 3 Mean numbers of *Bemisia tabaci* caught per week, weeks 13 to 46 in CC whitefly traps 1–30 and 2a–28a in the Imperial Valley, California during 1999 to 2002.

During 1999 to 2002, mean (\pm SE) numbers caught of adults/trap/week for traps 2a–28a were 2.5 ± 0.3 , $3.8 \pm$

0.8 , 3.0 ± 0.9 , and 1.1 ± 0.2 ; and 1.9 ± 0.2 , 1.9 ± 0.3 , 2.0 ± 0.3 , and 0.9 ± 0.2 adults/trap/week for traps 1–30.

Trap catches of *B. tabaci* were significantly correlated with the mean monthly minimum ($r = 0.719$, $P = 0.039$) (Fig. 4), but not maximum or average air temperatures, and rainfalls for 1996–2002. Mean monthly minimum temperatures were 8.0, 12.6, 14.9, 19.4, 21.0, 17.3, 9.6, and 5.1°C for April, May, June, July, August, September, October and November, respectively.

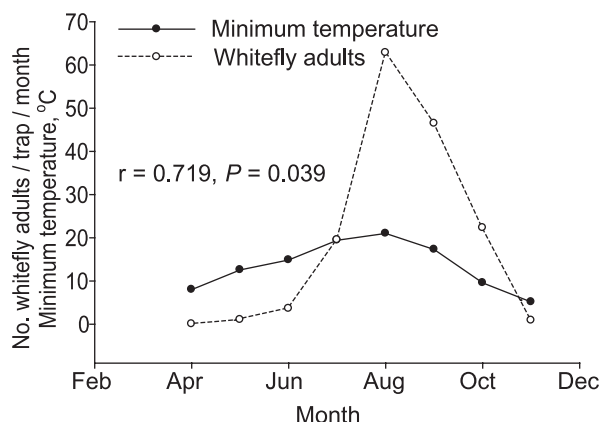


Fig. 4 Mean numbers of *Bemisia tabaci* caught in CC whitefly traps per month during February to December and minimum temperature relationships in the Imperial Valley, California during 1996 to 2002.

Discussion

Production of melons as a preferred *B. tabaci* host (Chu *et al.*, 1995) appears to be one of the factors that favored the development of *B. tabaci* B biotype populations during 1996 to 2002 in the Imperial Valley, California. Following spring and fall melon harvests, some evergreen perennial weeds occurred that served as intermediate hosts to support year-round populations (Natwick *et*

al., 2000). IPM programs initiated in 1992 in the Imperial Valley included the use of the insect growth regulators buprofezin and pyriproxyfen that conserved natural enemies, clean cultural practices that destroyed crop residues soon after harvest, systemic insecticides that reduced population development on melons and vegetables, and management techniques that delayed insecticide resistance were highly effective *B. tabaci* management strategies (Ellsworth & Martine-Carrio, 2001; Palumbo *et al.*, 2001). The implementation of these control actions over large areas of crop cultivation is assumed to be a major factor in yearly reduction in *B. tabaci* populations, although experimental evidence is not available.

Weather conditions during the growing seasons, particularly air temperatures, have been reported to influence numbers of *B. tabaci* caught in traps, reproduction, and population dynamics (Issacs & Byrne, 1998; Simmons & Elsey, 1995; Skinner, 1996). Karut *et al.* (2005) reported that for *B. tabaci* biotypes Q and B, minimum temperature was an activity-limiting factor in the Çukurova Plain, Turkey. Sekeroğlu *et al.* (2002) reported that *B. tabaci* trap catches increased with increases of average daily minimum temperatures from 16.4 to 19.7°C. Reduced trap catches of *B. tabaci* occurred in our study, reported herein, when minimum air temperatures ranged between 5.1–21.0°C. Weather factors do not appear to have accounted for the long-term *B. tabaci* population decreases that occurred in the Imperial Valley from 1996 to 2002. Gerling and Henneberry (1998) reported that declines of *B. tabaci* populations in Israel following epidemic outbreaks were typical for other invasive species, but reasons remain unknown. Stansly (1999) suggested that the declines in *B. tabaci* populations in Florida following epidemics were due to three factors: biological agents, management, and the use of the systemic insecticide imidacloprid in vegetable production. Our data support these suggestions and further reductions of *B. tabaci* populations in the agricultural system in the Imperial Valley may occur if melon production continues to decrease, and increasing efforts to conserve and augment biological agents that are adapted to the area are encouraged (Naranjo, 2003).

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